civil defense Technical Bulletin

Appendix 10

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A DIGEST OF TECHNICAL INFORMATION

FAMILY SHELTERS FOR PROTECTION AGAINST RADIOACTIVE FALLOUT

PURPOSE

This bulletin provides guidance to engineers, architects, contractors, and the general public in planning family shelters for protection against the effects of radioactive fallout.

FALLOUT

General

Whenever a nuclear bomb is exploded near the ground, large amounts of earth and debris are drawn upwards by the ascending fireball. The resulting cloud may rise to a height of 80,000 feet or more. Radioactively contaminated particles which fall back to earth from this cloud are termed "fallout." Some of these radioactive particles are deposited close to the point of burst soon after the explosion, while others may be carried several hundred miles by the winds before they settle to earth.

Period of Shelter Occupancy

In any locality in the United States, fallout could require occupants to remain in shelter for two weeks or more. In many areas, radiation levels may permit leaving shelter, for intermittent periods or permanently, after 2 or 3 days. However, since the intensity of fallout at any specific place is impossible to predict prior to an attack, it is advisable to plan for a 2-week occupancy.

Radiation Hazard

There are several types of radiation associated with fallout. From the standpoint of shelter, however, the most significant hazard is from gamma radiation. Gamma rays, like X-rays, are highly penetrating, and to secure adequate protection from them special standards for shelter are required.

STANDARDS FOR FALLOUT SHELTERS

Shelter Dimensions

The shelter should provide for each occupant at least 12½ square feet of floor area and 80 cubic feet of volume. In general, ceiling heights should not be less than 6½ feet. The width of the entranceway should be kept to an absolute minimum, usually not more than 2 feet.

Shielding

(*a*) The shielding must have enough mass to reduce gamma radiation to a relatively harmless level. The less dense the material used, the greater the thickness required for a given degree of protection.

(*b*) As a general rule, a high degree of protection against gamma radiation will be afforded by an earth cover of 3 feet or an equivalent mass of other material or combination of materials. Approximate thicknesses required for other materials to afford protection equivalent to 3 feet of earth are: concrete, 24 inches; iron and steel, 7½ inches; and lead, 3 inches.

(*c*) The arrangement of the entranceway is important since harmful amounts of radiation may be scattered around corners. Therefore, the designs of the entranceways, shown on the attached drawings, should not be altered. It may be noted from the drawings that the radiation must make at least two right-angled turns before entering the main chamber. These changes of direction effectively reduce the intensity of radiation.

Ventilation

(*a*) In a basement shelter a tolerable and safe environment may be obtained by providing the means for natural ventilation, such as a grilled entrance door. Under-

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ground shelters, however, require the use of mechanical blowers or fans.

(*b*) The shelter ventilation system should be capable of supplying not less than 5 cubic feet of fresh air per minute per person in the main chamber, and means should be provided to exhaust the stale air. The actual intake of air which should be supplied to the shelter at any given time depends to a large extent on outside temperature conditions. For warmer temperatures, 5 cubic feet per minute per person is desirable. However, colder outside air may require a reduction in the amount delivered to the shelter, but this should never be less than 3 cubic feet of fresh air per minute per person. If practicable, the ventilating system should create a slight overpressure inside the shelter to prevent the infiltration of contaminated particles. The use of fuel-burning apparatus in the shelter area should be avoided.

(*c*) Suitable ventilating blowers or fans are commercially available at nominal cost (see Appendix A, page 4). Hand-operated centrifugal blowers of the type used in blacksmith forges have appropriate pressure-capacity characteristics. At a somewhat higher cost, small positive-displacement rotary blowers may be obtained with alternative hand-crank and electric motor drives, the latter feature being optional. While continuous operation of the ventilating blower at peak capacity would be best, intermittent operation on a short time cycle may be satisfactory. However, if the blower in a closed shelter is not operated for periods exceeding two hours, hazardous air conditions may result.

(*d*) Dry-type particulate air filters with cells or canisters containing a pleated filter material made of cellulose-asbestos or fine glass fibers are preferred for use in the ventilating systems (see Appendix A, page 4).

Radio Equipment

A battery-operated radio is necessary equipment for the shelter. If it is to be stored there, precautions should be taken to prevent its deterioration. A supply of spare batteries is highly desirable. Since batteries also deteriorate with time, replacements should be made at least once a year. The shielding required for radiation protection also dractically curtails effective radio reception. For this reason, radios used in shelters may require an antenna outside of the shelter itself. Since portable radios are made with widely differing circuit characteristics, it is impracticable to describe a single type antenna system suitable for all radios. However, two methods that have proven satisfactory with the radios tested are:

(*a*) Placing the radio near the underside of the entrance door.

(*b*) Running a lead-in wire from an outside antenna into the shelter, wrapping it several times around the radio in the direction that gives the best reception, and then grounding the end of the lead-in wire.

If neither of these methods proves successful, a local radio serviceman should be contacted for information on the most appropriate antenna system.

Food and Water Supply

At least a 2-week supply of food and water should be available. This may be required for survival even though the radiation level permits leaving the shelter in less than two weeks, since food may not be immediately available from normal sources. Foods that can be eaten without cooking are preferred. Packages of food should be in sizes which will meet the needs of one meal only. At least one-half gallon of water per person per day is needed for drinking and sanitation purposes. Gallon glass jugs, tightly capped, and carefully packaged to prevent breaking are recommended for long-term storage.

Sanitation

The sanitary disposal of human wastes is necessary for health protection. A small container, such as a hospital bedpan or other emergency toilet facility, should be provided. Contents should be disposed of in a covered watertight container. At least two 5-gallon holding containers are required for the initial shelter period. Following this period it may be possible to leave the shelter for short periods for disposal. These containers should be charged with a small amount of lime and water for odor control. A 10-gallon covered container for food refuse also should be included.

Miscellaneous Supplies

Other supplies that should be available include: a first aid kit; cots, bunks, or sleeping bags; blankets; flashlight and an extra supply of batteries, or a hand operated generator type of flashlight; can and bottle openers; eating utensils; toilet tissue, towels, and soap; and household tools.

Continuous low level lighting may be provided in the shelter by means of a 4-cell hot shot battery to which is wired a 150 milliampere flashlight-type bulb. Tests have shown that such a device, with a fresh battery, will furnish light continuously for at least 10 days. With a spare battery, a source of light for 2 weeks or more would be assured. A flashlight or electric lantern also should be available for those periods when a brighter light is needed.

FALLOUT SHELTER TYPES

Outside Underground Shelter

Many designs may be developed for an outside, underground, family fallout shelter which will provide reasonably adequate protection from radiation. Concrete, masonry, steel, pressure-treated wood, or other suitable construction

material may be used. Three different shelter types are illustrated in the attached drawings (Appendixes B and C). It will be noted that all of these shelters are modifications of the basic underground family fallout shelter.

Basement Shelter

(*a*) In the construction of a new house with a basement, a family shelter may be incorporated in a corner of the basement in the manner illustrated in the attached drawing (Appendix D).

(*b*) The provision of fallout shelter equivalent to the basement shelter described above presents serious construction difficulties in existing houses. Placement of the large mass of shielding material for the roof of the structure in the restricted space, and the possibility of additional footings being required for the extra weight are the primary problems. A shelter of this type could be built into the basement of an existing house using lesser thicknesses of material, but a lesser degree of protection must be accepted by the occupants.

Aboveground Shelter

For areas of the country where underground shelters are not feasible, an aboveground shelter should be built. Any of the materials suggested for construction of an underground structure can also be used for this shelter. The total mass of shielding material, including the material of which the shelter is constructed, should be equivalent to three feet of earth. This may be provided by covering the structure with earth or sandbags. If the arrangement of the entranceway cannot meet the standards of paragraph c (p. 1) under "Shielding," the entrance door will require sandbagging from the inside.

The basic underground shelter, shown in Appendix B, with the entrance modified, could be placed aboveground and mounded over as described above.

Appendix A

A GUIDE TO CONTRACTS AND SPECIFICATIONS FOR USE IN FAMILY FALLOUT SHELTER CONSTRUCTION

If the services of a contractor are to be used in the building of a family shelter, it is generally advisable to have a written contract and technical specifications to supplement the drawings. A widely used and convenient contract form for construction of this size is the "AIA Short Form for Small Construction Contracts," which is available from the American Institute of Architects, the Octagon, Washington, D. C., for 25 cents. It would be impractical to write technical specifications to suit every local condition; however, the following summary of generally accepted construction materials and practices should be a useful guide:

EARTHWORK

The excavation should have side slopes gradual enough to prevent caving, or appropriate shoring should be provided. The soil from the excavation should be stockpiled near the site for later use as backfill if suitable for the purpose.

Material used for backfill and embankment should have debris, roots, and large stones removed before placement.

Backfill and embankment should be placed in horizontal lifts 12 inches thick or less and thoroughly tamped or rolled while in a damp condition.

The subgrade for the floor slab should be leveled and tamped to provide uniform bearing conditions for the structure.

The area surrounding the embankment should be sloped away at a minimum grade of 2 inches per 25 feet to provide good drainage.

CONCRETE WORK

The required compressive strength of the concrete in the attached OCDM designs is 3,000 pounds per square inch.

For details of concrete construction, the "Building Code Requirements for Reinforced Concrete (ACI 318–56)" should be followed. This publication may be obtained from the American Concrete Institute, P. O. Box 4754, Redford Station, Detroit 19, Mich., for one dollar.

DAMPPROOFING AND WATERPROOFING

Dampproofing and waterproofing specifications may be obtained from the nearest Federal Housing Administration Office, or any commercially acceptable specification may be used.

METAL WORK

The OCDM family fallout shelters were designed using deformed intermediate grade billet steel reinforcing bars. However, the shelters may be designed using other types of deformed steel bars. It is important that the builder insure that the bars to be used conform to the ACI Building Code referred to under "Concrete Work" above.

There are many types of commercially produced metal roof hatches that will adequately serve as shelter doors. However, as long as the door is weatherproof and durable, a job-made wooden door would be suitable.

The ventilation piping in the shelter should be installed in accordance with the practices outlined in the "National Plumbing Code (ASA A40.8–1955)." This publication may be obtained from the American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N. Y., for $3.50. All piping should be galvanized.

The rungs in the entrance hatch are standard ¾-inch deformed reinforcing bars. The unembedded portion should be painted to prevent rusting.

VENTILATING EQUIPMENT

Suitable ventilating blowers, air filters, and roof ventilators are available from many sources of supply, although fabrication details, and consequently the installation requirements, will differ for equipment furnished by the various manufacturers.

Positive-displacement blowers having both electric motor and geared hand-crank drives are manufactured by Roots-Connersville Blower Division, Connersville, Ind. Small centrifugal blowers having a geared hand-crank drive are made by the following manufacturers:

Buffalo Forge Co.,
450 Broadway,
Buffalo, N. Y.

Champion Blower and Forge Co.,
Harrisburg Ave. and Charlotte St.,
Lancaster, Pa.

Air filters of the type used for engine or compressor intake pipes are manufactured by the following concerns:

Dollinger Corp.
6 Centre Park,
Rochester 3, N. Y.

Fram Corp.,
Providence 16, R. I.

Purolator Products, Inc.,
970 New Brunswick Ave.,
Rahway, N. J.

Roof ventilators are made by the following manufacturers:

Air Devices, Inc.,
185 Madison Ave.,
New York City 16, N. Y.

G. C. Breidert Co.,
P. O. Box 1190,
San Fernando, Calif.

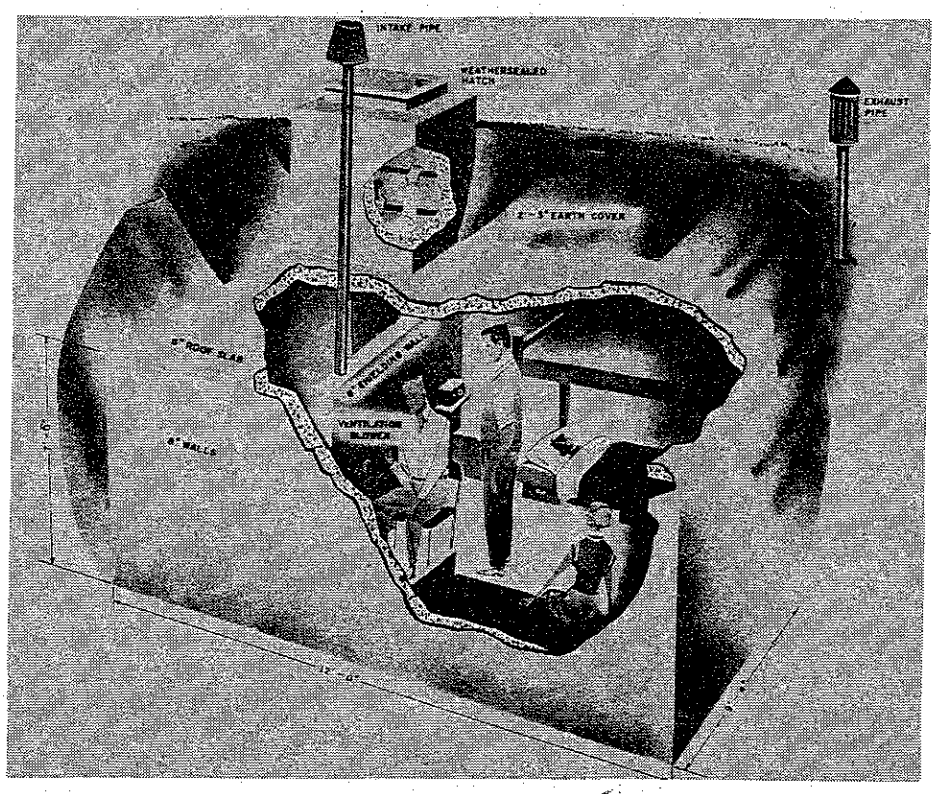
Penn Ventilator Co.,
3252 Goodman Ave.,
Philadelphia 40, Pa.

The names of specific manufacturers of blowers, filters, and roof ventilators are given only as examples, and do not denote a preference for their products. Local contractors, dealers, or distributors of heating, ventilating, and air conditioning equipment may be consulted when selecting equipment for a protective shelter.

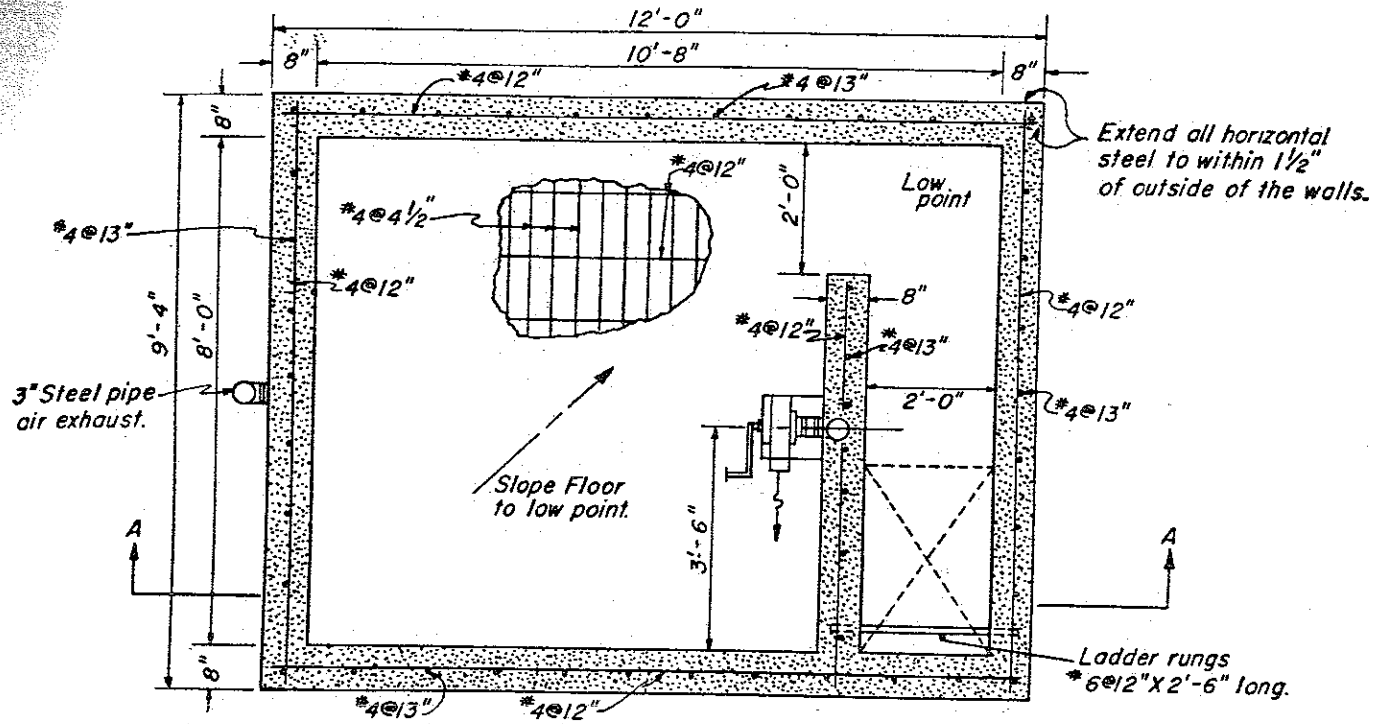
Appendix B

THE BASIC UNDERGROUND FAMILY FALLOUT SHELTER

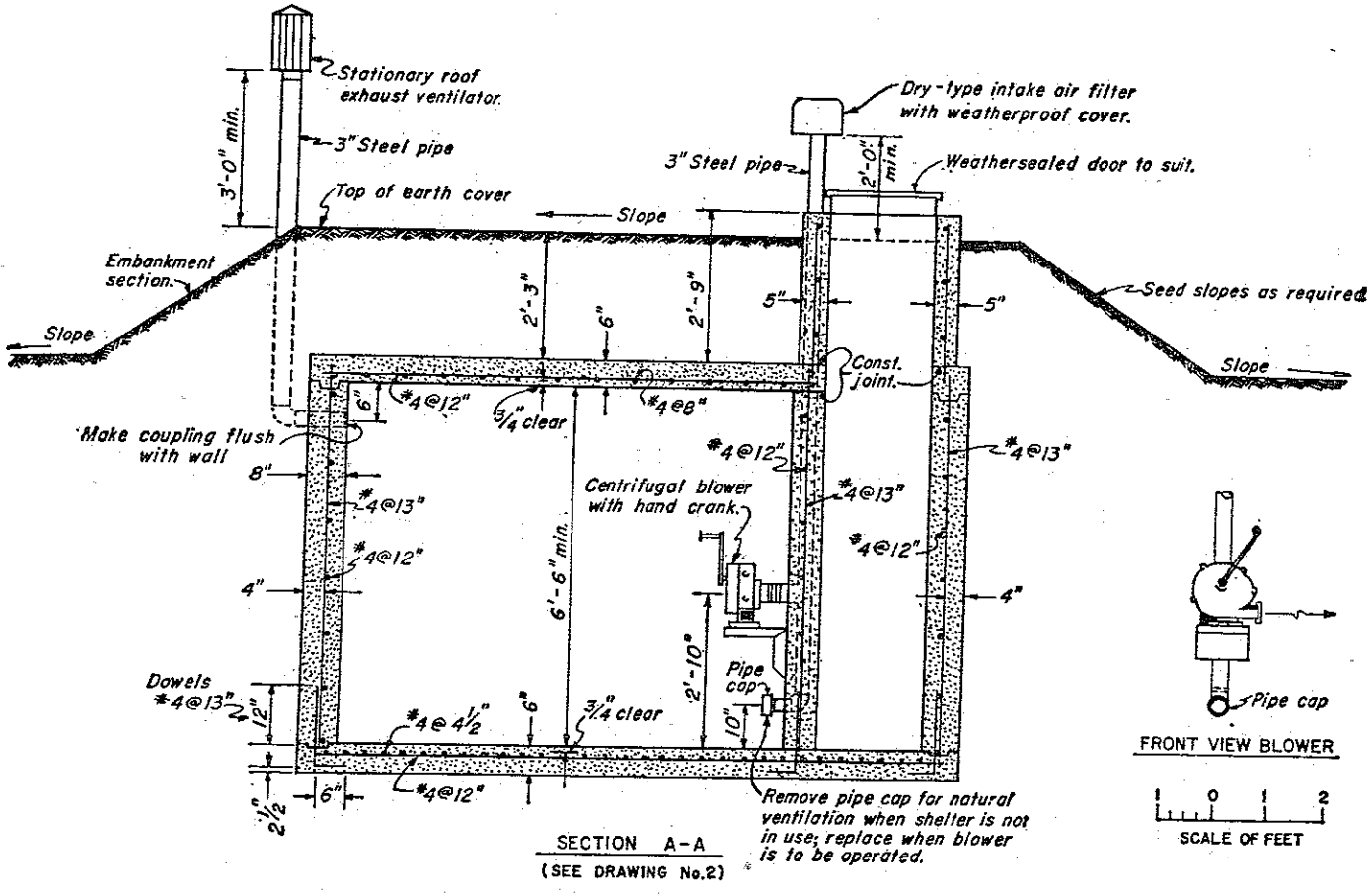
This reinforced concrete shelter has been designed to provide a high degree of protection from radioactive fallout for up to six adult occupants. The drawings show the shelter covered by an embankment 2 feet 3 inches high. If desired, the embankment may be eliminated by placing the roof of the shelter 2 feet 3 inches below ground level. The selection of which type of earth cover to use is optional since there is no significant difference in the amount of protection afforded. If the embankment is used, however, its slopes should be seeded or treated to prevent erosion.



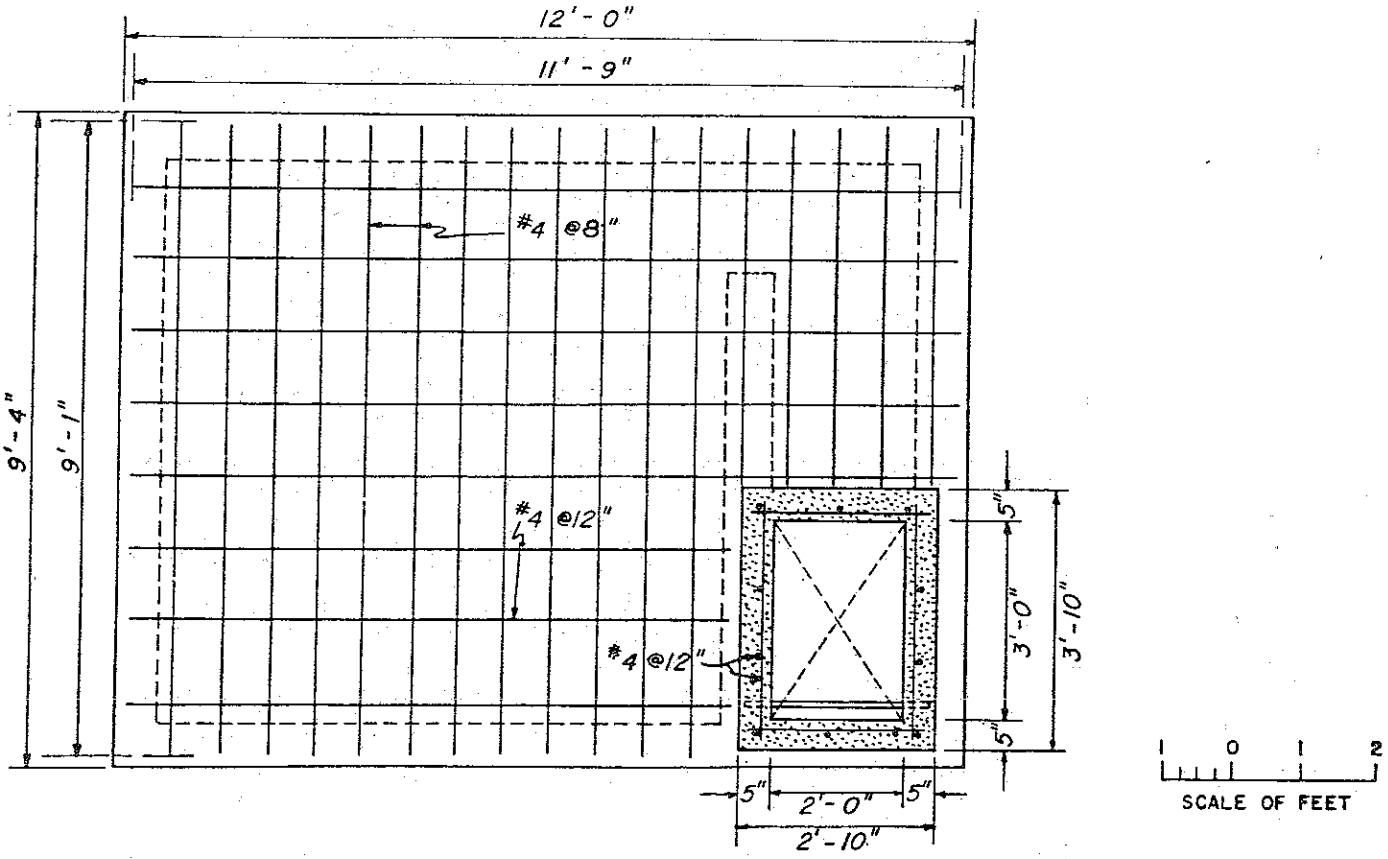
Appendix B, Drawing No. 1.—FAMILY FALLOUT SHELTER (4 to 6 persons).



Appendix B, Drawing No. 2.—BASIC UNDERGROUND FAMILY FALLOUT SHELTER—Plan.



Appendix B, Drawing No. 3.—BASIC UNDERGROUND FAMILY FALLOUT SHELTER—Longitudinal Section.



Appendix B, Drawing No. 4.—BASIC UNDERGROUND FAMILY FALLOUT SHELTER—Roof Slab and Entranceway.

Appendix C

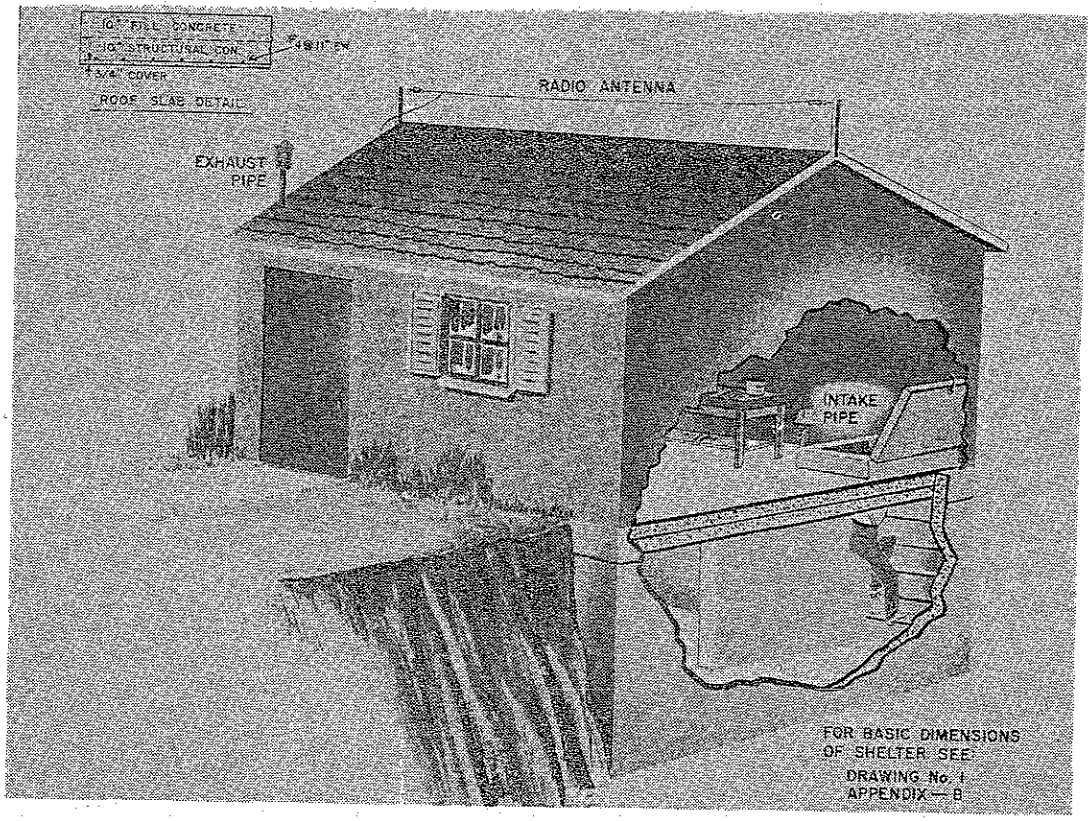
THE BASIC UNDERGROUND FAMILY FALLOUT SHELTER INCORPORATED INTO SMALL BUILDINGS

The basic underground family fallout shelter can be incorporated into the plans of basementless houses, garages, garden or tool houses, and the like (see drawings 1 and 2). There are only two structural modifications required. First, the slab thickness of the roof must be increased to 20 inches, and second, a "collar" of concrete or masonry must extend above the entranceway opening in the roof slab. The reinforcing bars of the walls and floor slab must be the same as in the basic shelter.

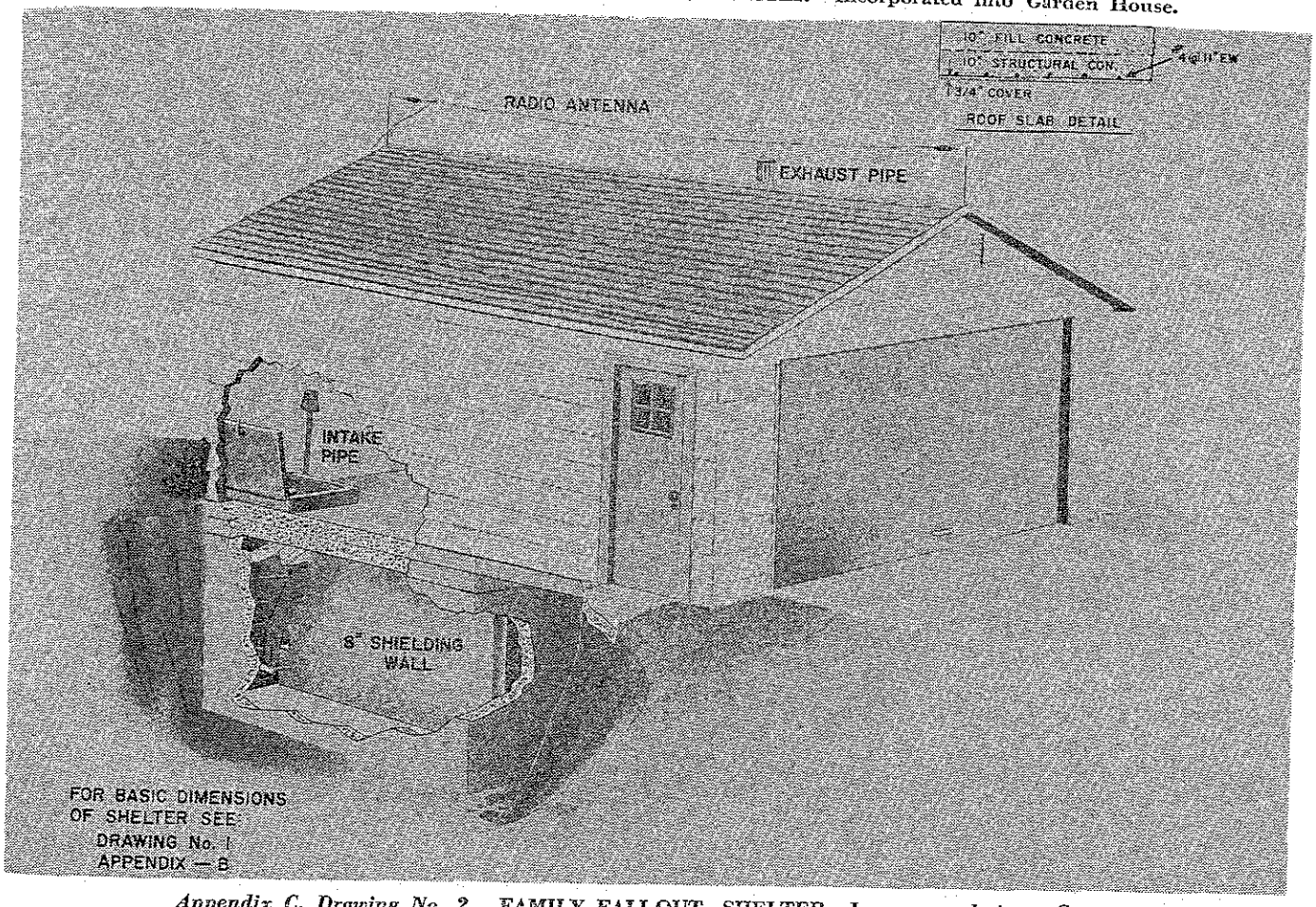
To meet recognized code requirements economically, the roof slabs should be placed in two 10-inch layers. The lower layer should contain the minimum amount of reinforcing steel required by code. The upper layer is for radiation protection only, and it should be placed and compacted with the same care as the structural concrete.

The "collar" should have a minimum height of 12 inches and width of 12 inches. These dimensions are based on radiation considerations. Since most commercially available door hatches have minimum inside dimensions of 2 feet 6 inches x 3 feet, the collar is of ample size to accommodate them, even though the actual opening is narrower.

The ventilation system should contain the same components as the basic shelter; however, the intake may be located within the small building and the exhaust outside, as shown on the drawings.



Appendix C, Drawing No. 1.—FAMILY FALLOUT SHELTER—Incorporated into Garden House.



Appendix C, Drawing No. 2.—FAMILY FALLOUT SHELTER—Incorporated into Garage.

THE BASEMENT CORNER ROOM FAMILY FALLOUT SHELTER INCORPORATED INTO NEW CONSTRUCTION

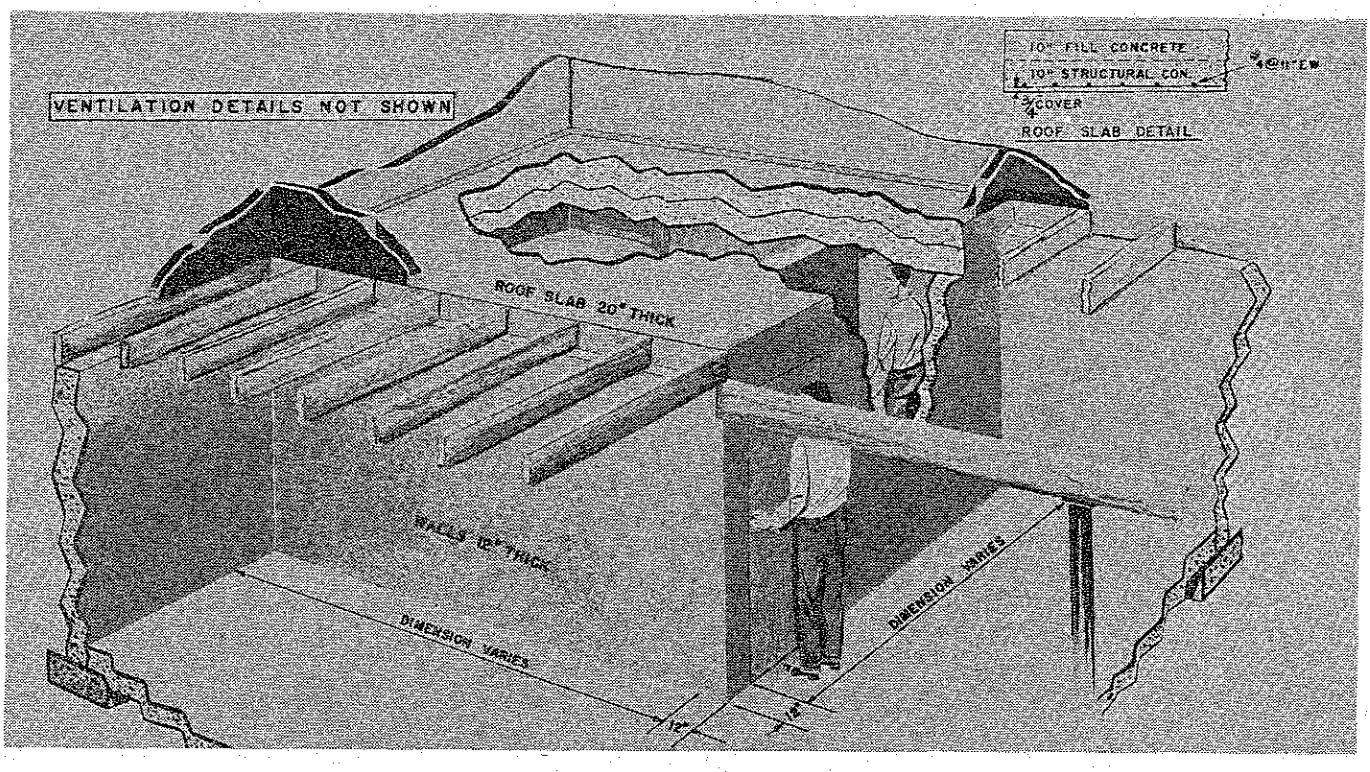
In this design (drawing No. 1) the two exterior walls of the shelter also serve as house foundation walls and the top of the roof slab is used as the floor for a room above.

Any contractor should be able to construct the basement corner room shelter without difficulty. Special care, however, should be taken in shoring the formwork for the heavy roof slab. Although not shown on the drawing, conventional wall footings should be added under the interior walls of the shelter.

To meet recognized code requirements economically, the roof slab should be placed in two 10-inch layers. The lower layer should contain the minimum amount of reinforcing steel required by code. The upper layer is for radiation protection only, and should be placed and compacted with the same care as the structural concrete.

The shelter may be built with either a natural or mechanical ventilation system. Natural ventilation may be achieved by having two grilles or louvers about 1 foot square in the entrance door. One grille should be near the top and the other near the bottom of the door.

If a mechanical system is used, it should contain the same components as the basic underground family fallout shelter except that a grille in the door may be substituted for the exhaust pipe.



Appendix D, Drawing No. 1.—BASEMENT FAMILY FALLOUT SHELTER (4 to 6 persons).

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For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 5 cents